



CITY OF FLAGSTAFF
International Dark Sky Association
2018 Annual Report



The winter sky from Lake Mary, near Lowell's dark-sky site at Anderson Mesa. Visible on the horizon is the sky glow from Flagstaff (right, 8 miles away) and Phoenix (left, 110 miles away).

(Photo by Jared Stern)

INTRODUCTION

The City of Flagstaff and the northern Arizona region have achieved worldwide recognition for innovative leadership in the protection of dark skies. Beginning with Ordinance 400 in 1958 that addressed searchlights, over a half-century of policy decisions and implementations have fostered an astronomy industry that now includes Lowell Observatory, the U.S. Naval Observatory, the Navy Prototype Optical Interferometer, the National Undergraduate Research Observatory, the U.S. Geological Survey Astrogeology Center, and the new Discovery Channel Telescope. Public support for protection of the night sky for both general enjoyment and professional deep space research has become an established element of community and regional identity.

Zoning Codes that restricted the amount of light per acre in outdoor lighting installations were approved by both the City and the County in 1989, and since then the codes have been periodically updated and strengthened. On October 24, 2001, Flagstaff was recognized as the world's First International Dark Sky City for its pioneering work balancing preservation of our night sky natural resource with concerns about public safety and economic security. Rather than allow this significant economic and cultural inheritance to be degraded, the region's hard-won reputation and accomplishments are acknowledged as vital assets that must continue to be enhanced.

To remain one of the premiere astronomic sites in the world, to properly recognize preservation of naturally dark night skies as a persistent expression of community values, and to better-utilize a critical economic and tourism attractant, the region must implement evolving standards that proactively address problems associated with increased artificial light, air pollution, illuminated signage, and development - both adjacent to major scientific instruments and within the region.

FLAGSTAFF REGIONAL PLAN 2030 GOALS AND POLICIES (No Updates in 2018)

Goal E&C.5. Preserve dark skies as an unspoiled natural resource, basis for an important economic sector, and core element of community character.

Policy E&C.5.1. Evaluate the impacts of the retention of dark skies regarding lighting infrastructure and regulatory changes, land use decisions or changes, and proposed transportation developments within the region.

Policy E&C.5.2. Encourage and incentivize voluntary reduction of "exempt" lighting that degrades night sky visibility, and work to prevent light trespass whenever possible in both public and private areas.

Policy E&C.5.3. Continue to enforce dark sky ordinances.

Policy E&C.5.4. Encourage uses within Lighting Zone 1 of the lighting codes of the City and County that do not require outdoor lighting and discourage those which require all-night lighting.

ZONING REGULATION OVERVIEW (No updates in 2018)

The City was recognized as the world's first International Dark Sky City on October 24, 2001 for its pioneering work in the development and implementation of lighting codes that balance the need to preserve Flagstaff's dark sky resource with the need for safe lighting practices. The purpose of the zoning regulations is to help assure that dark skies remain a resource to be enjoyed by the Flagstaff community and its visitors, and to provide safe and efficient outdoor lighting regulations that protect

Flagstaff's dark skies from careless and wasteful lighting practices. Dark starry nights, like natural landscapes, forests, clean water, wildlife, and clear unpolluted air, are valued in many ways by the residents of this community, and they provide the natural resource upon which our world-renowned astronomical industry depends.

The use of outdoor lighting is often necessary for adequate nighttime safety and utility, but common lighting practices can also interfere with other legitimate public concerns. Principle among these concerns is:

- The degradation of the nighttime visual environment by production of unsightly and dangerous glare;
- Lighting practices that produce excessive glare and brightness that interferes with the health and safety of Flagstaff's citizens and visitors;
- Unnecessary waste of energy and resources in the production of too much light or wasted light;
- Interference in the use or enjoyment of property that is not intended to be illuminated at night by light trespass, and the loss of the scenic view of the night sky due to increased urban sky-glow; and
- The impact of inappropriately designed outdoor lighting that disrupts nocturnal animal behavior, particularly migrating birds and other species.

The concerns of safety, utility, dark sky protection and aesthetic appearance need not compete. Good modern lighting practices can provide adequate light for safety and utility without excessive glare or light pollution. Careful attention to when, where, and how much night-time lighting is needed results in better lighting practices, darker skies and reduced energy use and costs.

It is therefore the intent of this Division to encourage lighting practices and systems which will:

- Minimize light pollution, glare, and light trespass;
- Conserve energy and resources while maintaining night time safety, utility, security, and productivity; and
- Curtail the degradation of the night time visual environment.

It is recognized that since topographic and atmospheric conditions surrounding the City are uniquely suited for astronomical observation and since observatories have been established in the City's vicinity, the City promotes the reduction of light pollution which interferes with the successful operation of these observatories.

The sensitivity of different areas to the different obtrusive impacts of outdoor lighting use depends on many factors, including the dominant use of the area (e.g. residential, industrial or commercial). Further, the effect of outdoor lighting on light pollution to the observatories is strongly dependent on the distance of those lights from the observatories. Therefore, three Lighting Zones are established, with varying standards designed to address the principal issues associated with the different areas.

ZONING CODE UPDATES (2018-2019)

The City of Flagstaff is in the process of updating the Outdoor Lighting requirements of the Zoning Code as identified in the Naval Observatory Flagstaff Station Mission Compatibility Light Pollution Study. The current requirements have been reviewed by a local lighting expert who has helped draft all of the lighting codes in Flagstaff and Coconino County since their inception. The code is expected to be

updated through a public hearing process during the next reporting year. An Executive Summary of the study is attached to this report. The recommendations from the Naval Observatory Mission Compatibility study included:

1. Encourage canopies in lighting zone I.
2. Extend requirements from lighting zone II into lighting zone II.
3. Identify and track lighting retrofits (non-conforming lighting).
4. Modernize measurement of absolute lumens.
5. Update residential roadway lighting.
6. Align residential average use standard.

LIGHTING ENFORCEMENT PROGRAM

Code Compliance investigates all reports of lighting violations and works with non-conforming properties to bring them into compliance. The City has continued to conduct annual audits to identify non-compliant properties and track progress.

In 2018 Code Compliance Staff responded to approximately 40 violation complaints. Most of these complaints were residential in nature and were found to be in violation of the outdoor lighting requirements. About half (20) of the registered violations are currently in compliance.

Staff received funds this last budget cycle to purchase a light spectrometer to assist with outdoor lighting compliance. A request was also made in the last budget cycle for an Outdoor Lighting Specialist to work full time on lighting compliance including night-time enforcement. While this position was not funded, staff continues to gather data and support for future requests which could include a shared position with Coconino County to increase outdoor lighting compliance. Staff will also explore grant funded opportunities that may exist in support of the Joint Land Use Study.

STREET LIGHTING TO ENHANCE DARK SKIES OVERVIEW

The Street Lighting for Enhancing Dark Skies (SLEDs) Project's primary objective is to find a solution to Flagstaff's current street lighting predicament while balancing dark skies, safety and maintenance/cost effectiveness objectives.

The SLEDs Project is the result of several years of discussions between the City and the local observatories (United States Naval Observatory – Flagstaff Station and Lowell Observatory) that started in May 2012. At that time, the City found itself in a lighting predicament as Low Pressure Sodium (LPS), the preferred lighting source since 1989, was becoming increasingly more expensive to purchase, quality replacement parts were becoming more difficult to acquire and the City was experiencing structural failures of the pole/mast arm connection due to the size and weight of the LPS fixture, especially in wind prone areas.

In June 2015, the Flagstaff City Council approved an Inter-Governmental Agreement (IGA) with the Arizona Department of Transportation (ADOT) to secure funding for the SLEDs Project. This was in the form of \$100K (FY16) to hire a Consultant Team (ultimately Monrad Engineering), \$200K (FY16) for test fixtures to support the Consultant Team's work, and \$370K (FY18) for the first phase of lighting replacements. All of the funding anticipated from the Flagstaff Metropolitan Planning Organization's (FMPO) Surface Transportation Program (STP) allocations.

The SLEDs Project is an opportunity for Flagstaff to demonstrate to other municipalities an innovative lighting solution for dark sky preservation with Light Emitting Diode (LED) technology that achieves municipal objectives for safety and cost effectiveness and astronomical objectives for maintaining dark skies and innovation that advances the industry or best practices for technology transfer that advances the purpose of preserving dark skies.

The Request for Proposals (RFP) for SLEDs defined the project's measures of effectiveness:

"The City seeks cost effective replacement technologies that (1) maintain or approximate current lighting levels and (2) do not adversely impact the City's dark sky natural resource or the missions of the Lowell Observatory and the U.S. Naval Observatory. In consideration of cost effectiveness, the City seeks to utilize existing light pole infrastructure."

"Measures of Effectiveness may include:

- Light uniformity
- (1) Brightness and (2) spectrum analysis from several perspectives including:
 - o On the street
 - o At the observatories
 - o General sky brightness
 - o Identification of ambient light levels (i.e. absence of streetlights)
- Color rendition
- Wind loading (Effective Projected Area)
- Public commentary on lighting levels and color rendition
- Life cycle costs including, but not limited to, initial capital expense, energy use, and maintenance"

In September 2015, the Consultant Team, led by Monrad Engineering, was awarded a \$100K contract to conduct applied research in order to develop a replacement strategy for the City's increasingly obsolete LPS street lights with newer technology (LED).

The SLEDs Team has worked through several tasks to date:

- An assessment of the viability of continuing to use LPS
- A structural analysis of existing light pole/mast arm assembly and retrofit recommendation for existing poles/masts
- Pre-installation observations and measurements of "sky glow" of the Cheshire and arterial test areas have been completed through ground, aerial and satellite measuring techniques
- Test fixture recommendations have been divided into two categories:
 - o Arterials and selected Major Collectors
 - o Selected Major Collectors, Minor Collectors and Local Roads
- Developed specifications for the Minor Collector / Residential Narrow Band Amber Light Emitting Diode (NBALED) test fixtures and Arterial Hybrid Light Emitting Diode (HLED) 80% NBALED/20% 2700K LED test fixtures and Arterial 12,000 lumen NBALED test fixtures

SLEDS Project items completed in 2018:

- Completed procurement of almost 200 test fixtures
- SLEDS Team identified test locations for the Arterial, Collector and Local roadway test strips
- Installation of test fixtures on various Arterial, Collector and Residential locations
- A bus tour was held with several residents and City Council members of both the Arterial and Local roadway test strips in May 2018
- An second evening tour of test strips was held coordinated with the local members of the Flagstaff Dark Skies Coalition
- The City is coordinating the SLEDS project with the Arizona Department of Transportation as ADOT is moving towards LED lighting replacements of legacy High Pressure Sodium installations in Flagstaff
- Solicited public feedback on the test installations through an on-line survey

SLEDS next steps:

- SLEDS consultant team draft Final Report is expected in late CY 2018
- SLEDS Team meetings to discuss results of the test areas and review of the draft Final Report
- Develop new City Engineering Standards for Street Lighting
- Develop City Wide replacement scenarios
- Finalize SLEDS Project Report and present to Public and City Council

NAVAL OBSERVATORY FLAGSTAFF STATION MISSION COMPATIBILITY LIGHT POLLUTION STUDY

In response to various development proposals over the past several years, the Naval Observatory Flagstaff Station (NOFS) completed a Mission Compatibility study to evaluate mission impact from light pollution, present findings, and outline recommendations for consideration by the City of Flagstaff and Coconino County to minimize the impact to the Dark Sky and the NOFS military mission.

The study sought answers to two questions:

1. What is the expected impact of development in the region on the Naval Observatory Flagstaff Station's (NOFS) observing conditions?
2. Are the current lighting standards and patterns of expected development compatible with the long-term ability of the NOFS to fulfill Department of Defense mission requirements?

The study was completed in three phases. Phase one quantified the current sky brightness at the NOFS. An inventory and analysis were completed of the existing and potential land uses in the region and finally a quantitative prediction of sky brightness resulting from new development. The second phase defined the maximum sky brightness that will be compatible with NOFS mission. Phase three developed six mitigation strategies to preserve the NOFS mission and operational capabilities.

The Executive Summary was presented at a Joint City Council/Board of Supervisors meeting on November 6, 2017 and City Council has given us a "Go" to proceed. City staff met with a local dark sky professional who has agreed to draft the proposed amendments to the current lighting standards. An executive summary of the proposed changes is attached to this report.

JOINT LAND USE STUDY OVERVIEW

The goal of the Joint Land Use Study (JLUS) is for local governments, stakeholders, and military installations to study, make recommendations, and provide a report that contains an implementation plan for compatible land use between the United States Naval Observatory Flagstaff Station, the Arizona Army National Guard Camp Navajo while also supporting diverse community values. Additionally, the purpose of the JLUS is to prevent incompatible uses surrounding military installations that may interfere with the ability to complete the mission of the facility and to limit impacts of the installations on surrounding property owners. Coconino County is the local sponsor for the proposed \$479,430 grant to hire a consultant to complete the JLUS with a local match of \$53,270.

A Request for Proposals was issued in the Springs of 2017 with the award granted to Makers, an architecture, planning and urban design consultant based in Seattle. Makers assembled a team that includes specialists in public participation, transportation and engineering. During 2018 a series of public meetings were held to develop policies related to the operations and impacts to the Naval Observatory. The draft JLUS report was released in September, 2018 for public review and comment. A joint Policy Committee and Technical Committee meeting was held on September 6, 2018 to review proposed policies. Appendix A of the JLUS report summarizes the relevant policies in specific categories, Dark Skies, Enforcement and Zoning Code and is attached to this report. The final report will be presented at a joint City Council/Board of Supervisors meeting on December 3, 2018. Adoption of the JLUS report by both jurisdictions is anticipated during the next reporting year.

Development in Lighting Zone 1

No new development projects have been submitted within the boundaries of Lighting Zone 1 since the last report. As an update to the 2017 report:

City of Flagstaff Public Works Yard – Completed and occupied as of July 2018.

The City worked with the local dark sky community and the Naval Observatory to receive a \$250,000 grant from the Military Installation Fund for dark sky compliant lighting at the new public works yard located on the west side of Flagstaff on Route 66. The new facility is located within Zone 1, the most restrictive zone located closest to the Naval Observatory. Zone 1 allows a maximum lumen allowance of 25,000 Lumens/Acre. The maximum allowable lumens for this 52-acre site is approximately 1.3 million lumens. A total of 796,582 lumens are proposed for the entire facility. Most of lighting fixtures are Narrow-Spectrum Amber LED (NSALED) light source. These fixtures are a mix of 90% NSALED and 10% white LED. Approximately 10% of the facility's outdoor lighting use a white LED light source.

Timber Sky Phase 1 - Currently under construction with homes anticipated early next year.

Timber Sky is a 1300 residential dwelling unit development with a mixture of high, medium, and single-family residential units combined with commercial service and open space on 197.58 acres. The development is located on West Route 66 in lighting zone 1, the most restrictive. An application to annex the site into the City and rezone the property was approved by City Council in November 2016. Working with the local dark sky community, the Timber Sky development committed to a series of strategies as part of their Development Agreement with the City of Flagstaff. The Developer is responsible for the enforcement of these provisions through their Covenants, Conditions & Restrictions.

- Lighting for each single-family home developed within the R1, MR and HR zoning categories will be limited to a total of 1350 externally installed lumens, whether attached to the dwelling structure or installed elsewhere on the lot. This limit can be exceeded with the use of motion sensors on fixtures such that the non-motion sensor light fixtures do not exceed the 1350 lumens limit.
- Exterior lighting on single family and multi-family residential structures will be fully shielded fixtures to be installed under canopies or overhangs a minimum of five (5) feet from the nearest edge not attached to the structure. In situations where an overhang is not feasible or practical, a fully shielded fixture with motion sensor will be utilized.
- All common area property owned or managed by the master homeowner's association, or one of the sub-associations within a residential block, will be limited to security lighting and lighted entry monuments. For purpose of applying the City of Flagstaff lighting code, lighted entry monuments will be considered Class 1 Lighting, and security lighting will be considered Class 2 Lighting. Care must be given to minimize lumens and to direct light downward or be completely shielded for these applications.
- With the exception of lighting for single family residential, and lighting for multi-family residential all outdoor lighting will use "low-pressure sodium, narrow-spectrum amber LED, PC amber LED, or amber compact fluorescent or equivalent.
- Care should be given to selecting building colors and materials where external lighting will be installed to minimize reflectivity. Wall surfaces located below and within ten feet laterally of any external light fixture will have a "light reflectance value" (LRV) of 15 or less.
- For commercial development within Block 12, Table 10-50.70.050.D of the City's lighting code requires outdoor lighting in Zone 1 to be turned off at 9:00 pm or no later than 30 minutes after the business closes, whichever is later. For any lighting fixtures exempted from this requirement in the lighting code, motion sensors will be utilized after 9:00 pm.

The City of Flagstaff approved a modification to development standards to not require street lighting on the residential streets within this development.

COMMUNITY OUTREACH AND EDUCATION



The milky way over the US Naval Observatory in Flagstaff. Courtesy Chris Luginbuhl

Arizona Daily Sun Article July 25, 2018 (This event occurred on Wednesday, July 25th, 2018@ 6:00 pm – 8:00 pm)

LET THERE BE NIGHT! Light pollution and the future of Flagstaff's observatories

Flagstaff is the world's first International Dark Sky City and home to two major observatories, but light pollution continues to threaten the night. Development is extending into areas near the Naval Observatory, and continued growth and addition of white LED lighting in Flagstaff and throughout the State is affecting all of Arizona. In Flagstaff, despite state-of-the-art lighting ordinances, poor lighting is too frequently installed without permit or review by local planning departments. The city's astronomy- and dark-sky-friendly low-pressure sodium street lights have become obsolete and must be replaced. Most street lighting around the world is being replaced by bright, white LEDs, which dramatically degrade night skies.

The observatories and dark sky advocates are taking notice. The U.S. Naval Observatory (USNO), located just five miles west of Flagstaff, is a dark-sky site for optical and near-infrared astronomy. USNO has determined that if there is a brightening of Flagstaff's dark skies of just 10% over current conditions its critical mission cannot be maintained. Lowell Observatory operates dark-sky sites on Anderson Mesa and near Happy Jack west and south of Flagstaff. Both sites are being exposed to increasing light pollution from regional and even statewide development.

Participants in the forum will be asked to contribute ideas and perspectives for how to preserve the region's dark skies and the future of its observatories.

Presenters will include:

Dan Folke, AICP, Interim Community Development Director for the City of Flagstaff; Dr. Jeffrey Hall, Director of Lowell Observatory; Julie Pastrick, President of the Greater Flagstaff Chamber of Commerce; Dr. Paul Shankland, Director of the US Naval Observatory Flagstaff Station; Dr. Michael West, Astronomer and Deputy Director of Science at Lowell Observatory

MEDIA RELATIONS

Code Compliance Handout “Working Together to Protect Flagstaff’s Dark Skies” Fall 2018



Coming together as a community,
we can all play a role in protecting
and sustaining our dark skies.

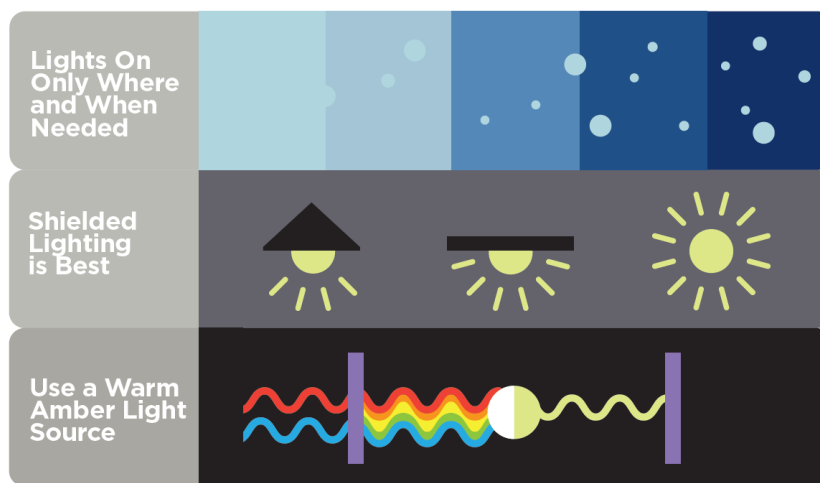
Working Together to Protect Flagstaff’s Dark Skies

Why are Dark Skies so Important?

Long before recorded history, mankind was gazing up at the stars in wonder and trying to understand our place in the universe. Today, starlit dark skies are disappearing so quickly that less than 20 percent of the population can still see the Milky Way. And this tragic loss goes far beyond visual beauty. Light pollution disrupts the natural 24-hour day/night cycle and has proven negative effects on the physiological processes of plants, animals, and people. In the Flagstaff area, dark skies are also critical to area observatories—as famous for their public and tourism value as for their groundbreaking scientific contributions.

That’s why we are so fortunate to be living in the world’s first international Dark Sky City, globally recognized for our pioneering work in innovative lighting codes. Lighting codes balance the protection of Flagstaff’s most unique resource with safe lighting practices that conserve energy and minimize artificial sky glow and glare.

Keeping Our Skies Dark



**You Must
Get a Permit
Before Changing
Light Bulbs
or Fixtures**

What do I need to do?

BUSINESSES AND INDUSTRY

New Construction: Outdoor lighting permits are required that define allowed lumens per acre

Existing Buildings: Permits are required before replacing any outdoor lighting bulb or fixture



www.flagstaff.az.gov/DocumentCenter/View/44090/Outdoor-Lighting-Application?bidId=



Outdoor Lighting Codes

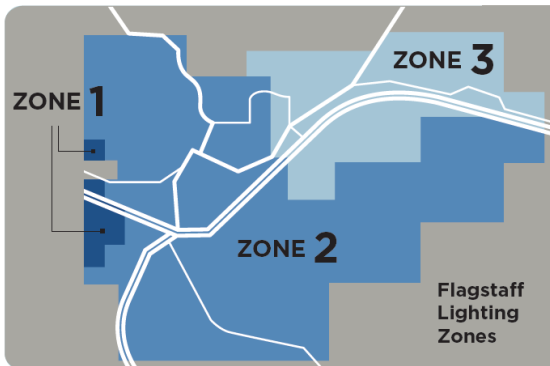
Flagstaff's protective regulations are designed to limit the adverse impacts of light pollution and apply to every building. These codes regulate three critical aspects of lighting hardware and systems:

- The amount of light
- The way light fixtures shield light
- The spectrum of light sources



All outdoor lighting fixtures must be installed to conform with Outdoor Lighting Standards 10-50.70 and the applicable building codes currently in effect in the City of Flagstaff. These regulations apply to:

- Existing buildings and uses
- New uses including buildings and major additions/modifications
- Minor additions/modifications such as changes in lighting
- Change of property use



Know Your Zone

Flagstaff's lighting zones have varying restrictions for larger-scale developments such as commercial, industrial, and multi-family housing complexes. Residential homes are limited to 10k000 lumens in all zones.

To learn what lighting is needed for your zone go to: www.flagstaff.az.gov/DocumentCenter/View/14494/Map10-9050-Lighting-Zone-Map?bidId=



Learn More

City of Flagstaff Community Development • 928-213-2618 • 928-213-2619
www.flagstaff.az.gov/DarkSkies

CITYSCAPE ARTICLE “Lights Out Flagstaff” Summer 2018

SUMMER2018



Lights Out Flagstaff

Join us at Lights Out Flagstaff on Friday, May 18, 2018, 7:30 – 9:30 pm, in Buffalo Park, for an evening filled with night sky telescope viewing, night hikes and other family-friendly activities celebrating our dark sky heritage. You can also learn about the dark skies lighting ordinance and how to be in compliance with it.

In celebration of Lights Out Flagstaff, Lowell Observatory will be hosting a Lights Out Flagstaff Happy Hour and Dark Sky Talk, followed by a bus ride to Buffalo Park for the main event. Happy Hour begins at 5:30 pm and runs until 7:30 pm. Beer will be provided by Dark Sky Brewery and a food truck and coffee cart will also be on site. Tickets for the Lowell Observatory portion of the event can be purchased by visiting www.lowell.edu/outreach/special-events. Find out more at www.flagstaff.az.gov/lightsoutflagstaff.

COMMUNITY PARTNERS & RESOURCES

Flagstaff Dark Skies Coalition

Our Mission: To celebrate, promote, and protect the glorious dark skies of Flagstaff and Northern Arizona through successful dark sky practices.

The Flagstaff Dark Skies Coalition website includes information on the Flagstaff Dark Sky program, lighting products and technical information on the science of lighting.

<http://www.flagstaffdarksdkies.org>

Lowell Observatory

Our mission is to pursue the study of astronomy, especially the study of our solar system and its evolution; to conduct pure research in astronomical phenomena; and to maintain quality public education and outreach programs to bring the results of astronomical research to the general public.

Lowell Observatory was founded in 1894 by Percival Lowell. Since then, Lowell astronomers have discovered Pluto, collected the first evidence of the expanding Universe, and measured the motions and properties of stars, among many other achievements. Today, Lowell Observatory continues to do research in all areas of astronomy and share our discoveries with all.

<https://lowell.edu>

United States Naval Observatory Flagstaff Station

The mission of the U.S. Naval Observatory, Flagstaff Station, is:

- To make, analyze, and interpret such astrometric and photometric dark sky observations as are required to fulfill the mission of the U.S. Naval Observatory.
- To conduct a research program to improve the observational methods and the accuracy of astronomical data required by the Navy and other components of the Department of Defense.
- To perform such other functions or tasks as may be directed by higher authority.

Established in 1955 a few miles west of Flagstaff, Arizona, the Flagstaff station is the US Naval Observatory's dark-sky site for optical and near-infrared astronomy. There are presently two USNO sites in the Flagstaff area: this station (NOFS) and the Navy Precision Optical Interferometer (NPOI), located some 15 miles south of the city.

<http://www.nofs.navy.mil>

ATTACHMENTS

- 2018 | **DRAFT** COCONINO JOINT LAND USE STUDY



APPENDIX A

IMPLEMENTATION

STRATEGIES

IMPLEMENTATION STRATEGIES

The 28 strategies in Chapter 3 are summarized in the following matrix and include priority level, anticipated time frame, and a rough estimated cost.

STRATEGY MATRIX

KEY

PRIORITY	1 = High 2 = Medium 3 = Low
ANTICIPATED TIME FRAME	I (Immediate) = first 2 years; I/O (Immediate/Ongoing); O (Ongoing) = ongoing; N (Near Term) = first 3 years; M (Medium Term) = 6-10 years
ESTIMATED COSTS	\$ = less than \$10,000; \$\$ = \$10,000 to \$50,000; \$\$\$ = greater than \$50,000

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
COORDINATION						
1 Establish a JLUS Implementation Committee and Memorandum of Understanding (MOU) to oversee JLUS strategy implementation.	1	County	City, Camp Navajo, NOFS, JLUS stakeholders	I	\$	Staff time
2 Improve notification and coordination between Coconino County, Flagstaff, NOFS, and Camp Navajo around potential land use activities and development projects in the study area.	1	City, County	NOFS, Camp Navajo	I	\$	Staff time
3 Coordinate with NOFS and Camp Navajo during regional, comprehensive, activity center, and other plan updates in the study area.	1	City, County	NOFS, Camp Navajo	O	\$	Staff time
DARK SKIES						
4 Establish an Outdoor Lighting Committee that meets regularly to help oversee: - Lighting code updates (approval process, code writing, communication/outreach, etc.). - Public relations campaign as outlined in strategy #26. - Ongoing information sharing between local observatories, City and County permitting, and code enforcement staff, so this occurs independent of individuals assigned to positions. - Completion and ongoing updates of a dark sky compliant fixture list and design guidance for homeowners and developers. List to be posted and disseminated as part of outreach strategy #26.	1	City, County	NOFS, Lowell, Dark Skies Coalition	I/O	\$	Staff time, volunteer time
5 Formalize communication between the USFS, Camp Navajo, and NOFS to minimize impacts of prescribed burns on NOFS mission.	1	USFS, Camp Navajo, NOFS	County, NAU	I	\$	Staff time
6 Designate a local Community Planning Liaison Officer (CPLO) to serve as NOFS's mission advocate and dark sky expert.	1	NOFS		I	\$\$\$	DoD / U.S. Navy

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
FOREST MANAGEMENT						
7 Support effort to site a wood processing plant within the JLUS Study Area and coordinate to: <ul style="list-style-type: none"> - Support the ongoing Biomass Feasibility Study in evaluating potential extent of and ability to mitigate for air quality and thermal impact on NOFS mission. - Build a proactive, robust framework to address air quality, water quantity and quality, and traffic impacts in the area. - Work with ADEQ to identify opportunities to leverage environmental analysis, outreach, and permitting process to increase knowledge of local aquifer health. - Explore options to use sustainable practices such as installing a closed-loop reclaimed water system. 	1	Camp Navajo, NOFS	County, ADEQ, AZDWR, USFS, Wood Processing Plant Developers	I	\$	Staff time
TRANSPORTATION						
8 To support development of an appropriately-sized interchange bridge in Bellemont: <ul style="list-style-type: none"> - Continue to advocate for and identify funding for increased capacity and multi-modal improvements to the interchange bridge. - Consider suggesting having bridge designed for five lanes but be built with three lanes in the near term. 	1	JLUS PC, County, ADOT	Camp Navajo, AZDEMA, ADOT, area businesses	I/O	\$-\$\$\$	Staff time, private enterprise, AZDEMA, Coconino County, ADOT
9 Coordinate proactively with ADOT to ensure projects consider area growth plans and lighting along roadways is dark sky compliant and work to address: <ul style="list-style-type: none"> - Transition of lighting in the study area to dark sky compliant - Planning and design of study area projects to ensure they support planned development, incorporate dark sky lighting, and enhance wildlife crossings. 	2	ADOT, Dark Skies Coalition	Camp Navajo, NOFS, County, City, AGFD, ASLD, NAU, FMPO, NACOG	O	\$	Staff time

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
PLAN UPDATES & POLICIES						
10 Support existing and adopt new goals and policies to best protect the missions of Camp Navajo and NOFS in the County's and City's Comprehensive Plan update.	1	City, County	NOFS, Camp Navajo	N	\$	Staff time
DARK SKIES						
11 Support adoption of the draft dark skies goals and policies in the Bellemont Area Plan.	1	County	NOFS	I	\$	Staff time
12 Prioritize development of designated activity center plans (specifically activity centers S10, U7, and S11 in the west).	1	City, County	NOFS, Camp Navajo, Lowell	N	\$\$\$	City, potential OEA funds
13 Support development of a Camp Navajo policy to comply with current and future Zone 1 lighting standards in order to protect dark skies.	2	Camp Navajo, Corps of Engineers	Dark Skies Coalition, NOFS	N	\$	Staff time
14 Recognizing dark sky regional assets, especially given the potential telescope location on Volunteer Mountain, adopt dark sky goals and policies in Williams.	2	Williams	NOFS, Camp Navajo, County	N	\$	Staff time
ENVIRONMENTAL HEALTH						
15 Understanding the important link between wildlife and land conservation, incorporate wildlife corridors into planning documents and land conservation efforts.	2	City, County	ADOT, Camp Navajo, AGFD, USFS, Central AZ Land Trust	O	\$	Staff time
TRANSPORTATION						
16 Update the 2015 Bellemont Access Management & Multimodal Study to account for potential growth as part of Camp Navajo and adjacent properties on the south side of I-40.	1	County	ADOT, Camp Navajo	I	\$\$- \$\$\$	Staff time; potential OEA funds; County

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
CODE UPDATES & ENFORCEMENT						
<i>CITY & COUNTY LIGHTING CODE</i>						
17 Periodically review and revise lighting codes to meet emerging technologies, similar to the ongoing process to incorporate the following NOFS Mission Compatibility Light Pollution Study code recommendations: - Update design standards to encourage/require overhang or canopy-mounting for outdoor lighting in Lighting Zone 1. - Extend Flagstaff's lighting zone 2 to cover all of existing zone 3. - Modernize measurement of absolute lumens. - Update residential roadway lighting requirements (consider making roadway lighting optional or eliminating requirement). - Align residential average use standard (consider allowing up to 10,000 lumens installed if average annual usage does not exceed 1,500 lumens).	1	City, County	Lighting Code Working Group, Outdoor Lighting Committee, NOFS, Dark Skies Coalition, Lowell	I	\$	Staff time
<i>CITY & COUNTY ZONING CODE</i>						
18 Continue to move toward City and County adoption of SLEDs Study recommendations for dark sky friendly lighting in the public right-of-way.	1	City, County	NOFS, Dark Skies Coalition, Lowell, Developers	I	\$	Staff time
ENFORCEMENT						
19 Fund a joint Coconino County and City of Flagstaff lighting specialist positions for education/enforcement in the next fiscal year (Spring 2019), responsibilities for this position include: - Establishing baseline database of non-conforming lights and a program/work plan to review problem parcels, updated annually. - Refining enforcement practices and policies to bring non-compliant fixtures into compliance with dark sky standards. - Convening an education series for elected officials, local leadership, staff, and community. - Providing periodic trainings for developers, realtors, design and building professionals, and existing property owners. - Creating a volunteer Dark Sky Ambassador Program and training volunteers to conduct outreach and education. - Leading efforts to develop training and education materials, such as presentations, fact sheets for permit applications and other uses, specification sheets, and outreach materials.	1	City, County	NOFS, Dark Skies Coalition, Lowell	N	\$\$\$	City, County, potential OEA funds (baseline database; education & training materials development), volunteer time (Dark Sky Ambassadors)

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
LAND CONSERVATION						
20 Continue to pursue funding to conserve critical private land in study area: - Continue to pursue ACUB & REPI program funding and partnerships to limit development on priority parcels in the study area. - Continue to coordinate with Trust for Public Land, the Nature Conservancy, and other NGOs to seek funding opportunities and expertise around priority parcel acquisition and conservation easements. - Explore partnering with the USDA National Resources Conservation Service.	1	Camp Navajo, NOFS	County, City, NGOs (i.e. TPL & Nature Conservancy), Central Arizona Land Trust, AGFD	O	\$\$\$	REPI/ACUB, AZDEMA, DoD/Navy
21 Continue to pursue funding to conserve critical Arizona State Trust Lands in the study area and advance one or more of the following: - Continue to advocate and educate regarding the importance of conservation of Centennial Forest and other ASLD study area parcels to the NOFS and Camp Navajo mission. - Explore amending state constitution to make potential land swaps for military protection more feasible. - Explore opportunities to reinvigorate the Arizona Preserve Initiative (API), with milestones and performance measures to designate critical parcels for conservation, and fund acquisition of Centennial Forest and/or other priority parcels (potentially using REPI/ACUB funds) - Identify and pursue other opportunities to protect critical State Trust land parcels in the study area.	1	NOFS, AZDEMA, ASLD	NAU, NGOs (i.e. TPL & Nature Conservancy), County, AGFD	O	\$	Staff time
22 Work with AZ legislature to revitalize the Military Installation Fund by: - completing a statewide prioritization of parcels, and - granting the Military Affairs Commission the authority to make offers on land.	3	AZDEMA	County	M	\$	Staff time

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
FOREST MANAGEMENT						
23 Support County Forest Restoration Director in efforts to coordinate forest restoration activities. Responsibilities that support JLUS goals include: <ul style="list-style-type: none"> - Assisting NOFS in developing processes for communication regarding prescribed burns and visibility. - Developing materials and outreach plan to educate community on the importance of thinning and address sensitivity around "healthy" forest image. - Consider creation of a Resource Protection Overlay (RPO) zone in the county, similar to the City of Flagstaff's overlay, that integrates tree protection provisions supporting dark skies with appropriate thinning practices to promote forest health. - Explore the opportunity to expand forest thinning contracts in the study area to include private lands and State Trust land. - Exploring the opportunity to use "hot shot" crews or forestry students to assist with forest thinning in the study area. 	2	County	USFS, NOFS, Camp Navajo, ASLD, NAVFAC, NAU	M	\$	Staff time
24 Improve practices to reduce wildfire risk on Camp Navajo with the following: <ul style="list-style-type: none"> - Update Camp Navajo's safety management practices to include wildfire aversion measures. - Set up a system to communicate to trainees/visitors. - Continue to conduct forest restoration activities to improve operations and reduce the threat of high-severity wildfire. 	1	Camp Navajo		I	\$	Staff time
25 Support forest restoration activities outside of installations to reduce the threat of high-severity wildfire in the study area.	3	NAU, USFS	JLUS Stakeholders	M	\$	Staff time

STRATEGY	Priority	Primary Responsible Party(ies)	Secondary Responsible Parties	Anticipated Time Frame	Estimated Cost	Potential Funding Source
EDUCATION						
DARK SKIES						
26 Develop and execute a public relations campaign to increase dark skies awareness and encourage action that could include: <ul style="list-style-type: none"> - Developing web-based and other resources to assist the public with dark sky compliant lighting implementation, include FAQs, and elements that build awareness/encourage replication of regional best practices and successes. - In coordination with military Public Affairs Officers, creating dark sky brochures for City and County staff to share with the public. - Supporting efforts to amend area Homeowners Associations' (HOAs) governing documents to implement dark sky compliant lighting. - Posting and advertising the dark sky compliant fixtures, brands, and design guidance developed in strategy #4 to assist suppliers, developers, and the public in meeting standards. 	1	Dark Skies Coalition, NOFS, Lighting Code Working Group	County, City, Lowell	N	\$-\$-\$	Staff time, potential OEA funds
MILITARY INSTALLATIONS						
27 Organize and launch initiatives to increase the general public's understanding of military operations, economic contributions, and the importance of compatibility. Efforts could include: <ul style="list-style-type: none"> - Issuing more frequent and user-friendly communications from the bases through newsletters, website updates, press releases, social media, and in person attendance at events and meetings. - Developing tools, presentations, and illustrations to increase general awareness of military missions, economic contribution, and importance of compatibility in the state. 	3	AZDEMA		M	\$	Staff time
28 Work with AZ legislature to notify property owners within certain distances of military installations.	3	AZ Military Affairs Commission	AZDEMA	M	\$	Staff time

Naval Observatory Flagstaff Station (NOFS) Mission Compatibility Study - Executive Summary

In response to various development proposals over the past several years, the NOFS has undertaken a Mission Compatibility Study (Study) to evaluate mission impact from light pollution, present findings, and outline recommendations for consideration by the City of Flagstaff and Coconino County to minimize the impact to the Dark Sky and the NOFS military mission.

Objectives of Mission Compatibility Study

- Measure and analyze of the existing Dark Sky at NOFS;
- Project the impact of new development on the Dark Sky;
- Evaluate the mission impact at NOFS from light pollution; and
- Develop recommendations and mitigation strategies to minimize impact to the Dark Sky and the NOFS military mission.

Findings and Recommendations

To prevent adverse impact to the NOFS military mission, while continuing to foster economic development and vitality of Flagstaff and Coconino County and sustain the Dark Sky quality of life, six (6) recommendations and mitigation strategies were proposed in the Study:

1. Encourage Canopies in Lighting Zone I

- Light escaping upward into the sky is decreased by approximately 50% when fixtures are mounted to the side of a building with a low-reflectance (15%) surface with increasing reductions as the fixtures are moved under canopies and further from the outer edge of a canopy or overhang.

2. Extend Requirements of Lighting Zone II into Lighting Zone III

- Merging Lighting Zone II into the current Lighting Zone III could reduce potential Sky Brightness at NOFS from future development by approximately 11%.

3. Identify and Track Lighting Retrofits

- Assemble a database of existing nonconforming lighting including fixture locations, lamp types, wattages, and a photo of each fixture type. Proactively review all nonconforming parcels on an annual basis.

4. Modernize Measurement of Absolute Lumens

- Conventional light fixtures on average waste about 30% of the light emitted by the light bulbs through absorption of light into the surrounding light fixture making them approximately 70% efficient. Light-Emitting Diodes (LEDs) are 100% efficient with no emitted light absorbed by the light fixture. The City and County lighting codes were adopted based on the measurement of lumens from conventional bulbs and fixtures, not LEDs. Therefore, when LEDs are now proposed for outdoor lighting under the current lighting codes, the 70% efficiency of conventional bulbs and fixtures is exchanged with the 100% efficient LEDs resulting in significantly more light emissions.

5. Update Residential Roadway Lighting

- Review residential roadway lighting requirements and consider reducing residential roadway lighting standards by making roadway lighting optional or eliminate the requirement from the Flagstaff Engineering Design Standards and Specifications.

6. Align Residential Average Use Standard

- Current lighting codes measure lumens at maximum output rather than the actual lumen output over time. To mitigate this problem and to avoid the issue of a direct reduction in total installed lighting, the Study recommends that up to 10,000 lumens for single family residences may be installed, provided that average usage does not exceed 1,500 lumens averaged over a calendar year.